

Climate Change Public Health Impacts: Strategies for Adaptation

Helene G. Margolis, PhD, MA



Source: NASA

California Resources Agency
Climate Adaptation Strategy
July 31, 2008
Sacramento, CA



Environmental Health Investigations Branch
Division of Environmental &
Occupational Disease Control

University of California, Davis
Department of Internal Medicine



Overview

- Climate Change Public Health Impacts: Opening Thoughts
 - Comment on the current 'big picture'
- Environmental Impacts of Global Warming & Sequelae
- Public Health Protection: Everyday Strategies
- Considerations in Building Climate Change related Adaptive Strategies
- Public Health Impacts: Closing Thoughts

Public Health Impacts: Opening Thoughts

Climate change will lead to amplification of:

- ❖ Most existent public health challenges....
- ❖ Including health risks known to be associated with outdoor and indoor environments....

Currently no great surprises. *(...but that can change quickly)*

Amplification & new risks will highlight and/or reveal weaknesses in public health and societal infrastructures.

Those weaknesses reflect vulnerabilities – at level of region, State, local (County, community, neighborhood), populations & individuals

Identification & tracking of those vulnerabilities in advance of crisis will serve us well in mitigation of climate change impacts.

Environmental Impacts of Global Warming & Sequelae

Greenhouse Gases =>

◇ Changing Climate**

- ↑ Long-term Ave. Temp.
- ↑ Freq. Hot Days/Nights
(& Heat Waves) §
- ↓ Freq. Cold Days/Nights
- ↑ Heavy Rainfall Events
(without ↑ in total annual precipitation)
- ↓ Snowfall & Snow pack
- ↓ Mountain Glaciers
- ↑ Drought
(Areas, Freq. & Duration)
- ↑ Tropical Cyclones & Hurricanes
(Freq. & Intensity)
- ↑ Extreme High Sea Level

◇ Plant Growth (CO₂)

◇ Ozone & photochemicals

Exposures/Pathways

◇ Extreme Weather Events

Short- & Long-time-course events:
Heat waves, storms, floods,
hurricanes, tornadoes, droughts

◇ Coastal & Ocean Changes

◇ Air Pollution (O₃, PM, GHG)

◇ Nuisance Plants,

↑ Biomass

Allergens (e.g., Ragweed)

◇ Wildfires

◇ Toxins (e.g., Pesticides, algal blooms)

◇ Ecological Shifts =>

Distributions & abundance of:

◇ Vector-Borne Disease
hosts, vectors, pathogens

◇ Water-Borne Pathogens

◇ Water Supply & Quality

◇ Food Supply & Quality

◇ Population Displacement

§ ...and more humid (Gershunov & Cayan, 2008)

Health Outcomes

◇ Acute Morbidity/Mortality

Injury & complications of injuries
(e.g., wound infections)

Heat-related illness

Chronic dz. acute events

Toxin-related illnesses

◇ Chronic Disease

Respiratory

(Asthma, COPD, Allergy)

Cardiovascular

(Atherosclerosis, ...)

◇ Communicable Disease

Emergent & Re-emerging

VB: *West-Nile, Lyme Disease,
viral encephalitides, malaria,
dengue, hantavirus, Rift
Valley fever*

WB: *Cholera, cryptosporidiosis,
campylobacter, leptospirosis*

◇ Psychosocial Distress/ Mental Health

* Source: IPCC Climate Change 2007: The Physical Science Basis: Summary for Policymakers

Public Health Protection: Everyday Strategies

CDPH Strategic Goals: (3 of 5 Overarching Goals)

Goal 1: Increase Quality and Years of Healthy Life, Reduce Disparities and Promote Health Equity

Goal 2: Prepare for, Respond to, and Recover from Emerging Public Health Threats and Emergencies

Goal 3: Improve Quality and Availability of Data to Inform Public Health Decision Making

Central to Goal 1 & 2 is Prevention (*and achieving Goal 3*)...

....any activity which reduces the burden of mortality or morbidity from disease.

- **Primary prevention:** Actions to avoid the development of a disease.
 - Most population-based health promotion activities.
- **Secondary prevention:** Actions aimed at early disease detection, to increase intervention options that prevent progression of the disease and emergence of symptoms.
- **Tertiary prevention:** Actions that reduce the negative impact of an already established disease by restoring function and that reduce disease-related complications.

Public Health Protection: Everyday Strategies

Identification and Definition of Scope of the Problem

Surveillance of Disease/Condition or Environmental Factors that underlie or contribute to condition.

Health Impact & Vulnerability Assessments

Who is affected Where?

Regions, communities, populations, individuals.

What are the determinants of occurrence, severity, and outcome?
Exposure, biological susceptibility, socioeconomic influences.

Vulnerability Assessments & Cumulative Risks

What options for 1^o, 2^o, 3^o prevention?

Clinical Knowledge & availability of interventions.

What is capacity of public health network...and is the network in place to respond – in **long-term** and under **short-term emergency conditions**?

Public Health Protection: Everyday Strategies

Development of Strategies & Actions to Reduce Burden of Disease (examples)

Primary Prevention

Prevention of obesity prevents many chronic diseases and reduces risk of acute events due to chronic disease




Nutrition: increase knowledge about healthy food choices & actions to make those choices accessible

Physical Activity: increase knowledge about benefits, build into daily lives of children & adults.

Influence design and development of built environment that promote behavioral change...

In development of strategies...always need to think multi-dimensionally
e.g., do not go outdoors when excessive heat, high air pollution, or when high pollen counts for those with asthma or allergies.

Development of Strategies & Actions to Reduce Burden of Disease



Report a Dead Bird or Squirrel
call toll free:
1-877-WNV-BIRD
(1-877-968-2473)

[HOME](#) | [REPORT A DEAD BIRD OR SQUIRREL](#) | [WNV FAQs & BASICS](#) | [NEWS](#) | [RESOURCES](#) | [REPORTS](#) | Last Updated: Jul. 29, 2008 11:31 AM

[PARTICIPATING AGENCIES](#) | [CA DEPT. OF PUBLIC HEALTH](#) | [UC DAVIS CENTER FOR VECTORBORNE DISEASES](#) | [MOSQUITO AND VECTOR CONTROL ASSOC. OF CA](#) | [CA DEPT. OF FOOD AND AGRICULTURE](#)

CASE COUNTS BY COUNTY

Human cases (13)

County	Human cases
Alameda	-
Alpine	-
Amador	-
Butte	-
Calaveras	-
Colusa	-
Contra Costa	-
Del Norte	-
El Dorado	-
Fresno	1
Glenn	-
Humboldt	-
Imperial	-
Inyo	-
Kern	-
Kings	-
Lake	-
Lassen	-
Los Angeles	4
Madera	-
Marin	-
Mariposa	-
Mendocino	-
Merced	-
Modoc	-
Mono	-
Monterey	-
Napa	-
Nevada	-
Orange	2
Placer	-
Plumas	-
Riverside	-
Sacramento	-
San Benito	-
San Bernardino	-

Latest West Nile Virus Activity in California

Human data is updated every Tuesday and Friday by 4pm. Dead bird and squirrel data are updated every Wednesday by 4pm. Horse, mosquito and sentinel chicken data are updated every Friday by 4pm.

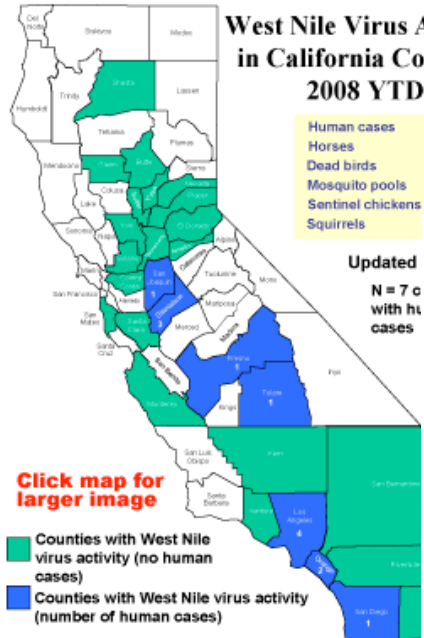
West Nile Virus Activity in California Counties 2008 YTD

Human cases	13
Horses	4
Dead birds	557
Mosquito pools	462
Sentinel chickens	23
Squirrels	-

Updated N = 70 with human cases

HUMAN CASES

YTD: 13 Counties: 7
There was 1 new WNV positive human case reported in California this week from Los Angeles County. There have been 0 WNV-related fatalities reported in California this year. 13 human cases from 7 counties have tested positive for WNV in 2008.



Click map for larger image

Counties with West Nile virus activity (no human cases)
Counties with West Nile virus activity (number of human cases)

Total Counties with WNV in 2008: 28
Amador, Butte, Contra Costa, El Dorado, Fresno, Glenn, Imperial, Kern, Los Angeles, Monterey, Orange, Placer, Riverside, Sacramento, San Bernardino, San Diego, San Joaquin, San Mateo, Shasta, Solano, Stanislaus, Sutter, Tulare, Yuba, and Yuba.

- View Print


BE A WEST NILE WATCHER

Help us track down the West Nile Virus by reporting all dead birds and squirrels. Call 1-877-968-2473 to report a dead bird or squirrel or you can submit an online report.

[Begin Online Report](#)

2003-2007 WNV ACTIVITY SUMMARY

Element	2003	2004	2005	2006	2007	Total
Human cases (fatal)	3 ¹ (0)	779 (29)	880 (19)	278 (7)	380 (21)	2,320 (76)

 [Click here for a printable version of the 2004-2008 WNV Case Summary](#)

Element	2003	2004	2005	2006	2007	Total
Horses	1 ²	540	456	58	28	1,083
Dead birds	96	3,232	3,046	1,446	1,395	9,215
Mosquito samples	32	1,136	1,242	832	1,007	4,249
Sentinel chickens	70	809	1,053	640	510	3,082
Squirrels	-	49	48	32	26	155

¹ There were 20 imported human cases. ² There were 3 imported horse cases.

Participating Agencies:

California Department of Public Health | UC Davis Center for Vectorborne Diseases | California Department of Food and Agriculture | Mosquito and Vector Control Association of California

Mosquito logo © copyright www.FightTheBiteColorado.com. Used with permission.

Physical Environmental Factors: Exposure Modifiers

Environmental Impacts of Global Warming & Sequelae

Exposures/Pathways

- ◇ Extreme Weather Events
 - Heat Waves
 - Floods
 - Droughts
- ◇ Wildfires
- ◇ Air Pollution (O₃, PM, GHG)
- ◇ Nuisance Plants
 - Allergens (e.g., Ragweed)
- ◇ Toxins (e.g., Pesticides, algal blooms)
- ◇ Ecological Shifts =>
 - Distribution & abundance of:
 - ◇ Vector-Borne (VB) Disease hosts, vectors, pathogens
 - ◇ Water-Borne (WB) Pathogens
- ◇ Water Supply & Quality
- ◇ Food Supply & Quality
- ◇ Population Displacement

Exposure
Modifiers

Health Outcomes

- ◇ Acute Morbidity/Mortality
 - Injury & complications of injuries (e.g., wound infections)
 - Heat-related illness
 - Chronic dz. acute events
 - Toxin-related illnesses
- ◇ Chronic Disease
 - Respiratory
(*Asthma, COPD, Allergy*)
 - Cardiovascular
(*Atherosclerosis, ...*)
- ◇ Communicable Disease
 - Emergent & Re-emerging
 - VB: *West-Nile, viral encephalitides, malaria, dengue, hantavirus, Rift Valley fever*
 - WB: *Cholera, cryptosporidiosis, campylobacter, leptospirosis*
- ◇ Psychosocial Distress/
Mental Health

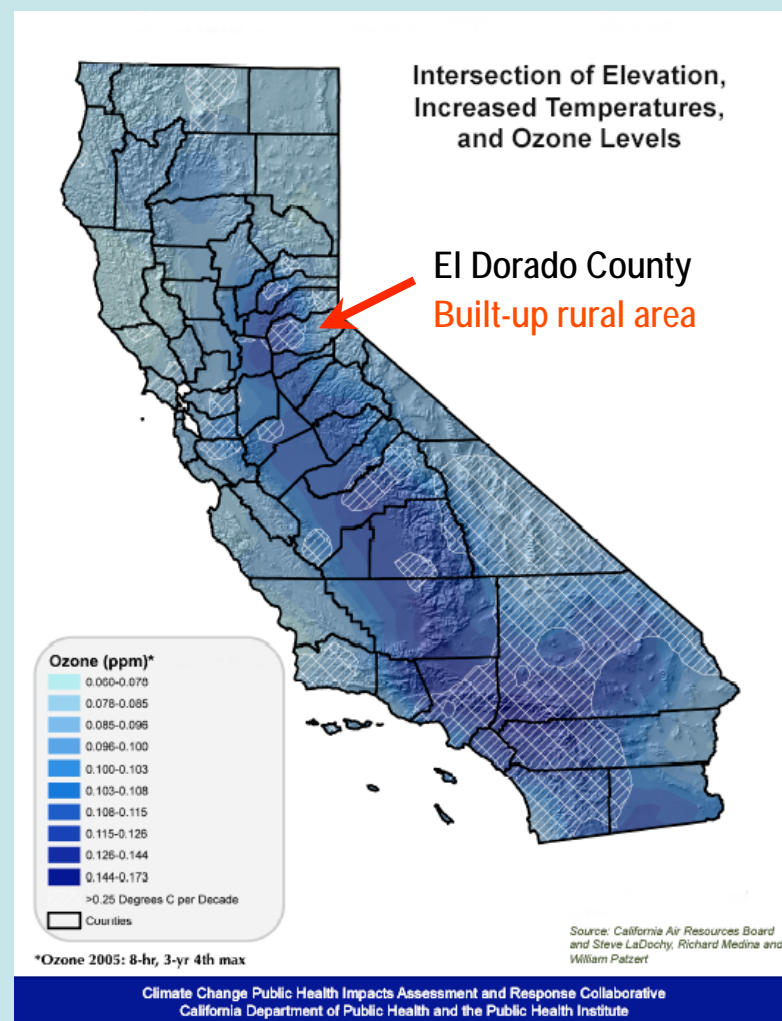
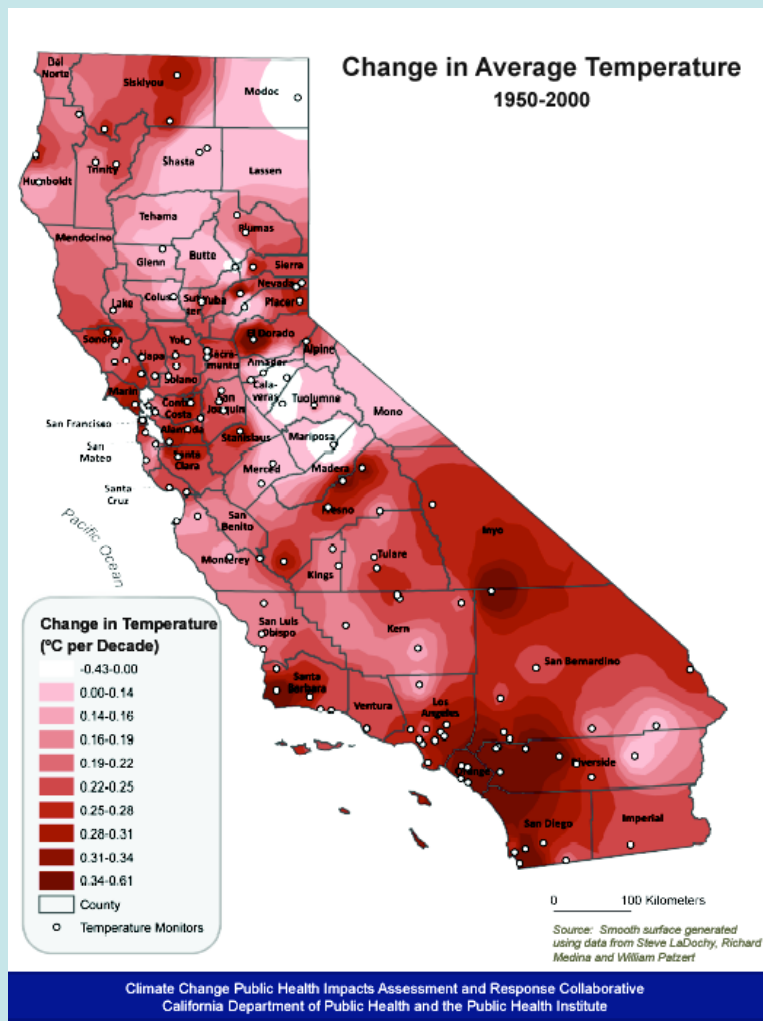
Physical Environmental Factors

Exposure Modifiers

- Location-Time-Activity Patterns (including cultural behaviors)
 - Children (Different patterns, behaviors & exposures)
 - Older adults
 - Physically & cognitively impaired (May not remove themselves from harm)
 - Time outdoors (work, leisure activities) & Time indoors
 - Ozone associated with 3-fold increased risk of new onset asthma among children who participate in ≥ 3 team sports
McConnell et al., Lancet 359: 386-391, 2002.
- Built Environment – Outdoor & Indoor Factors
 - Building Age, type, condition, heating/cooling systems (presence/usage)
 - Indoor Conditions (Wide variation in quality of indoor environments)
 - Community Design (Trees, impervious surfaces, land-use)
- Co-exposures (additive, synergistic)

Public Health Impacts: Simultaneous Risks

Built Environment & Co-Exposures: Heat Islands, Topography & Ozone



Susceptibility Factors: Biological/Physiological/Clinical Factors

Environmental Impacts of Global Warming & Sequelae

Exposures/Pathways

- ◇ Extreme Weather Events
 - Heat Waves
 - Floods
 - Droughts
- ◇ Wildfires
- ◇ Air Pollution (O₃, PM, GHG)
- ◇ Nuisance Plants
 - Allergens (e.g., Ragweed)
- ◇ Toxins (e.g., Pesticides, algal blooms)
- ◇ Ecological Shifts =>
 - Distribution & abundance of:
 - ◇ Vector-Borne (VB) Disease hosts, vectors, pathogens
 - ◇ Water-Borne (WB) Pathogens
- ◇ Water Supply & Quality
- ◇ Food Supply & Quality
- ◇ Population Displacement

Susceptibility Factors

Health Outcomes

- ◇ Acute Morbidity/Mortality
 - Injury
 - Heat-related illness
 - Chronic dz. acute events
 - Toxin-related illnesses
- ◇ Chronic Disease
 - Respiratory
 - (Asthma, COPD, Allergy)
 - Cardiovascular
 - (Atherosclerosis, ...)
- ◇ Communicable Disease
 - VB: *West-Nile & other viral encephalitides, malaria, dengue, hantavirus, Rift Valley fever*
 - WB: *Cholera, cryptosporidiosis, campylobacter, leptospirosis*
- ◇ Psychosocial Distress/
Mental Health

Susceptibility Factors: Biological/Physiological/Clinical Factors

- Age (< 5 years, ≥ 60 years)
- Sex (vs. Gender)
- Race/Ethnicity
- Genetics
- Pre-existing Chronic Disease, e.g., CVD, respiratory (asthma, COPD), diabetes, renal insufficiency, immunologic competency disorders
 - Example of physiology: people with COPD have different breathing patterns – may be more likely to 'mouth-breathe' => by-passes normal respiratory air-filtering mechanisms => increased risk of infectious agents and higher doses of air pollutants reaching distal airways.
- Clinical management of chronic disease
 - Access, adequacy, quality of care
 - Medications may decrease or increase risk of climate-change-related adverse health outcomes (e.g., for some exposures -- anti-inflammatory agents ↓ risk, diuretics ↑ risk)
- and interactions among any of the above.....

Socioeconomic/Behavioral & Cultural Factors

Environmental Impacts of Global Warming & Sequelae

Exposures/Pathways

- ◇ Extreme Weather Events
 - Heat Waves
 - Floods
 - Droughts
- ◇ Wildfires
- ◇ Air Pollution (O₃, PM, GHG)
- ◇ Nuisance Plants
 - Allergens (e.g., Ragweed)
- ◇ Toxins (e.g., Pesticides, algal blooms)
- ◇ Ecological Shifts =>
 - Distribution & abundance of:
 - ◇ Vector-Borne (VB) Disease hosts, vectors, pathogens
 - ◇ Water-Borne (WB) Pathogens
- ◇ Water Supply & Quality
- ◇ Food Supply & Quality
- ◇ Population Displacement

SES/Behavioral
Factors

Health Outcomes

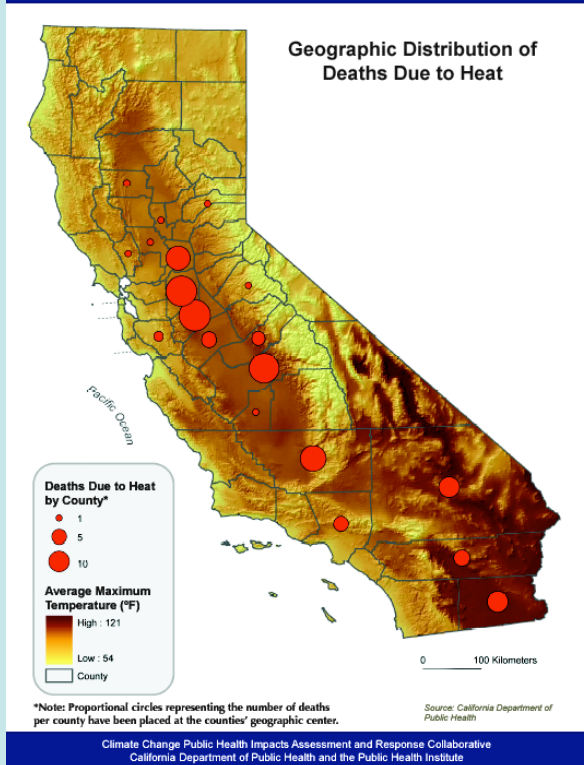
- ◇ Acute Morbidity/Mortality
 - Injury
 - Heat-related illness
 - Chronic dz. acute events
 - Toxin-related illnesses
- ◇ Chronic Disease
 - Respiratory
 - (Asthma, COPD, Allergy)
 - Cardiovascular
 - (Atherosclerosis, ...)
- ◇ Communicable Disease
 - VB: *West-Nile, malaria, dengue, encephalitis, hantavirus, Rift Valley fever*
 - WB: *Cholera, cryptosporidiosis, campylobacter, leptospirosis*
- ◇ Psychosocial Distress/
Mental Health

Socioeconomic, Behavioral & Cultural Factors

- Demographic Determinants of Vulnerability
 - Age
 - Gender (vs. sex)
 - Race/Ethnicity
 - Education
 - Economic factors
 - Employed (& type of employment), unemployed
- Built Environment & Location-Time-Activity Patterns
 - Building Age, type, condition, heating/cooling systems (presence/usage)
 - Time-outdoors (work, leisure activities)
 - Community-level factors (e.g., dominant industry, well-water, health-care)
 - Disparities (and consequences of disparities) in quality of indoor environments – homes, schools, work places
- Lifestyle Factors
 - Exercise
 - Diet/nutrition: quality, quantity, subsistence cultures' food sources
 - Psychosocial support
 - Living conditions (e.g., alone & isolated, crowding)
 - Psychosocial stress
 - Community infrastructure

Public Health Impacts of Climate Change in California: Community Vulnerability Assessments and Adaptation Strategies

Figure 6:



99% of cases lived in zip codes
where > 50% of residents live
below Poverty Guide Line

Hispanic cases -- younger

Source: R. Trent, T. Kim. 2007. CDPH

"2006 CA Heat Wave: Classic Heat Stroke" 126 cases
(vs. "Exertional Heat Stroke")

- Mostly older adults
- Chronic Disease Conditions
 - Cardiovascular 47%
 - Psychiatric 23%
 - Alcohol abuse/dependence 17%
 - Pulmonary 7%
 - Confined to bed 2%
- Heat exposure occurred indoors in most cases.
- **Air Conditioning**
 - 1 person reported to be using air conditioning prior to death.
 - No AC, or not reported 74%
 - Not functional 13%
 - **Functional but not used 13%**

www.ehib.org/papers/Heat_Vulnerability_2007.pdf

Public Health Impacts of Climate Change in California: Community Vulnerability Assessments and Adaptation Strategies

- Economic impacts of heat wave on dairy industry ~ \$1 Billion.
2006 CA heat wave kills 16,500 dairy cows statewide.
(Other estimates – 25,000 in Central Valley or 1% of State's Dairy Herd succumbed plus 70,000 poultry (*Source: <http://news.bbc.co.uk/1/hi/world/americas/5223172.stm>*)
Central Valley saw disruption of animal breeding and
>10% reduction in milk-production. *Source: Fresno Bee: Mark Crosse*
- Wide array of potential "downstream" public health risks
e.g., water quality, communicable disease, psychosocial stress



Misters give cows some relief at Pacheco Dairy in Kerman, Fresno County.

Source: Fresno Bee/Mark Crosse



Source: Modesto Bee/Marty Bicek

Public Health Impacts: Closing Thoughts

Vulnerability, Disparities & Social Responsibility

To reduce vulnerability at individual, population or community levels:

- Promote good health (reduces risk, increases resilience)

- Ensure access to health care, medical management

- Improve standard of care for all groups (Increase physician awareness)

- Reduce potential exposure (individual, community)

 - Prevention & Response

 - Ensure response is adequate & does no harm

 - (e.g., cooling centers & transportation; not fans)

In developing/applying solutions think about **unintended consequences**.

Investment of resources to mitigate climate-change health impacts can also contribute significantly to improvement of overall health of the public.

Public Health Impacts: Closing Thoughts

Actions

Public health networks

- Develop a comprehensive and coordinated strategy to prevent or mitigate the hazards posed.
- Strategies can capitalize on existing surveillance systems and databases to detect, track, evaluate, prepare for and respond to those hazards with optimum adaptive strategies.
- Capitalize on existing public health, clinical and societal infrastructure to apply adaptive strategies.
- Identify weaknesses in infrastructure/strategies & fix.

Public Health Impacts: Closing Thoughts Actions

- Public health and environmental protection strategies need to be integrated, complementary...
 - For example – Community actions to increase air conditioning in residences, need to be accompanied by actions that promote more green-energy production strategies.
- Public health and environmental protection strategies need to be *Equitable*.
- Public health community needs to be a partner in promotion of ‘climate change solutions.’
- Education & Outreach
 - Get the messages right & get them coordinated.

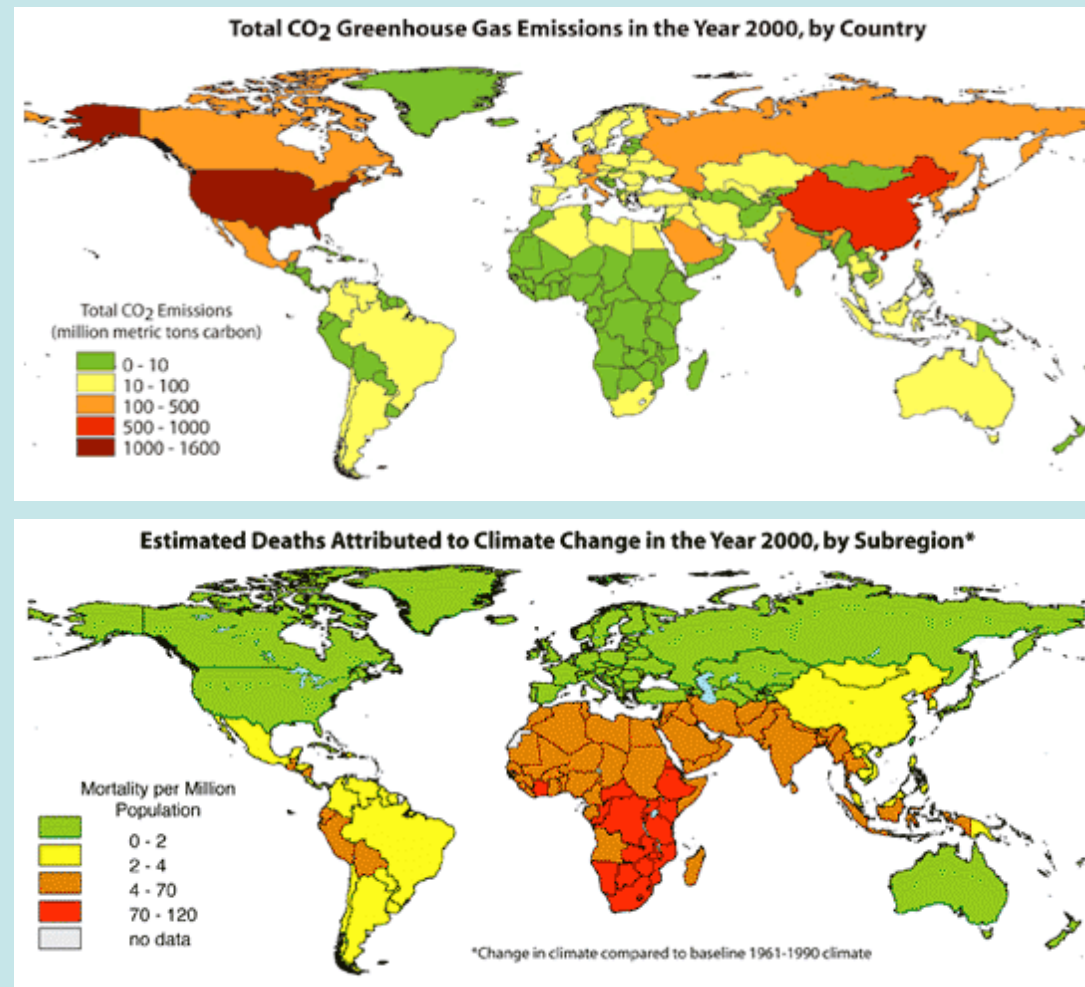
Public Health Impacts: Closing Thoughts

Significant Barriers to Adaptation Strategies

- Public Health Community is not officially at the AB32 Greenhouse Gas Emission Reduction Table –
Diminishes ability to influence decisions that could either enhance public health or prevent unintended consequences.
- Resources for Routine Activities are limited & during Crisis may not be adequate
 - Surveillance
 - Interventions
- Absence of legislative mandate to lead State activities related to prevention & mitigation of climate change public health impacts....
But ultimately responsible for prevention of deaths and illness!!!

Public Health Impacts: Closing Thoughts

Global Responsibility



Source: Patz, J. *Nature*: 438 (November 2005)

“Climate Change Public Health Impacts Assessment and Response Work Group”

CDPH: EHIB

Helene Margolis, Ph.D., M.A.

Paul English, Ph.D., M.P.H.

Thomas Kim, M.D.

Kathleen Fitzsimmons, M.P.H.

CDPH: EPIC

Roger Trent, Ph.D.

Jacquolyn Duerr, M.P.H.

CDPH: DCDC

Anne Kjemtrup, D.V.M., Ph.D.

Jonathan Kwan, Ph.D.

CDPH: EHLB – IAQS

Jed Waldman, Ph.D.

OEHHA

Bart Ostro, Ph.D.

Scripps Institution of Oceanography

Alexander Gershunov, Ph.D.

UC Berkeley/LBNL

Thomas McKone, Ph.D.

Richard Jackson, M.D.

NRDC

Gina Solomon, M.D., M.P.H.

Miriam Rotkin-Ellman, Ph.D.

Zev Ross Spatial Analysis

Ithaca, NY

Contact Information:

Helene G. Margolis, Ph.D., M.A.

hmargoli@cdph.ca.gov

helene.margolis@ucdmc.ucdavis.edu

916-552-9837

California Department of Public Health
Environmental Health Investigations Branch
<http://www.cdph.ca.gov>

*Thank
You!*

